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(56) Documents Cited
GB 2001012 A GB 1094627 A US 4168673 A
US 3797438 A US 3490406 A

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(54) **Floating oil platform with conical columns**

(57) A floating offshore construction (1), comprising a bottom part divided into chambers and with columns (2) in the peripheral area, which project above the surface of the sea and the top area of which is designed for the installation of a deck. The columns (2) are cone-shaped with the smallest diameter in the upper area, preferably the top area. One or more of the columns (2) can be eccentrically cone-shaped (see Figs 3 and 4 not shown).

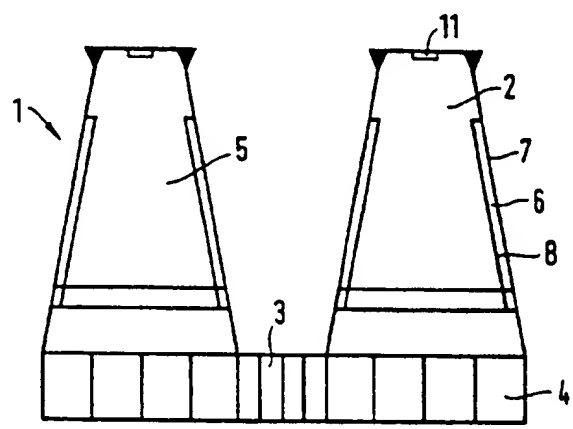

Fig. 1

At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

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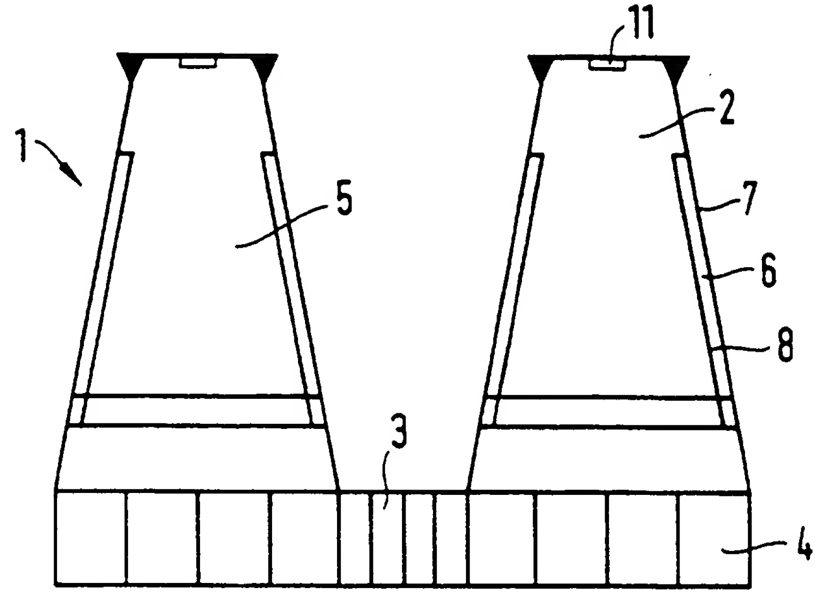

Fig. 1

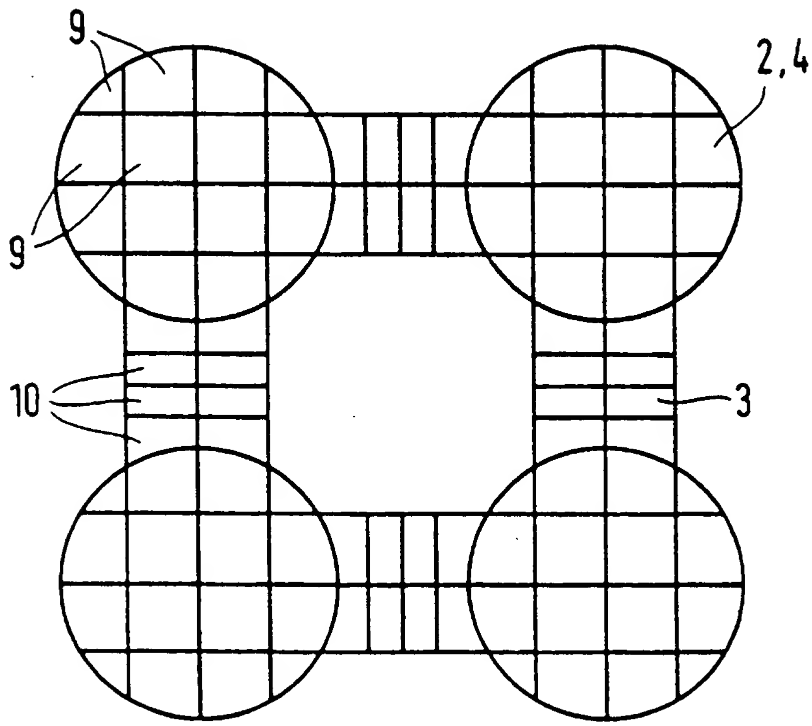

Fig. 2

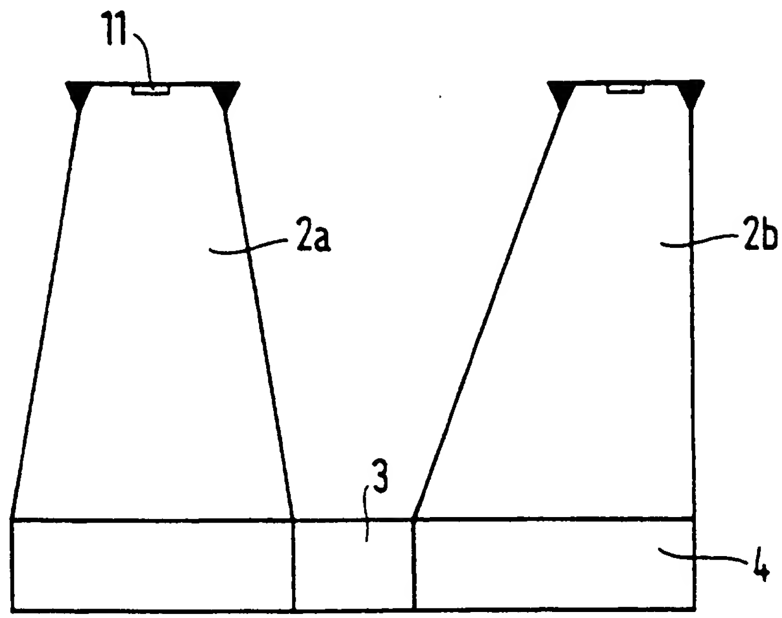

Fig. 3

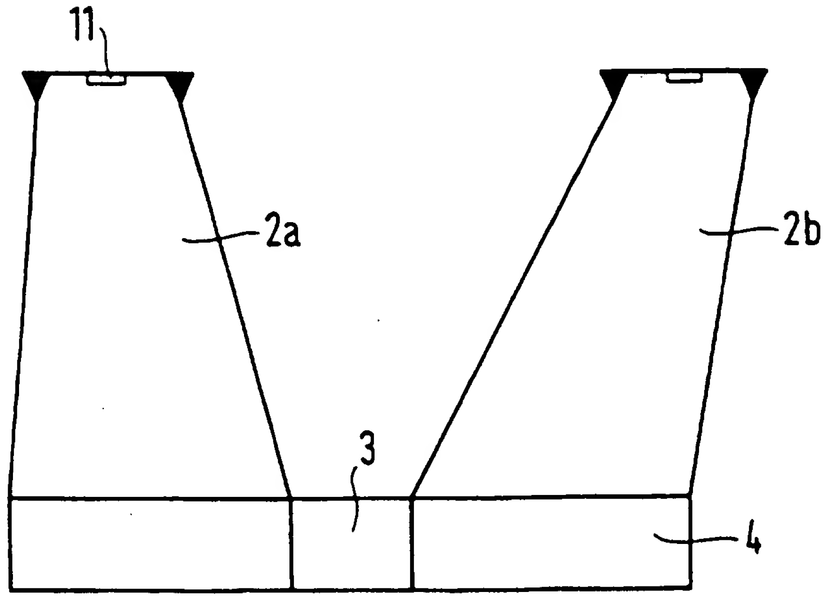

Fig. 4

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A floating oil platform foundation with conical columns

The invention concerns a floating offshore construction for supporting a platform deck in the production of oil or gas at sea, wherein the foundation comprises a bottom part divided into chambers and with columns in the peripheral area which project above the surface of the water and the top area of which is designed for the installation of a deck.

It is known for floating constructions of concrete to be used as a support for platform decks in the production of oil and gas at sea, wherein the foundation consists of a plurality of columns, which, in addition to the task of supporting the platform, can also contain equipment and constitute storage tanks for oil. A construction of this kind is made of steel or concrete, and if the latter is used, lightweight concrete is preferred. The columns are connected at the bottom to pontoons, the columns and the pontoons thus forming vertical and horizontal sides respectively in a box-like structure with open sides. This bottom part can also be designed in a different manner.

A platform foundation will always be subject to certain constructional and functional conditions in the form of requirements with regard to buoyancy in order to support the deck with sufficient freeboard, storage capacity for oil, stability during towing to the installation site and operation, hydrodynamic properties, the capacity for ballasting in order to achieve sufficiently low freeboard when coupling up to the deck, load-carrying capacity at the mounting points for the deck and the distance between these, etc.

The constructional requirements will be reflected in the design; for example the requirement for a low natural frequency is better satisfied with a heavy platform than with a light one, the requirement for stability is better satisfied with a platform with a low centre of gravity, etc. The requirements will also encroach upon one another; for example a requirement for increased storage capacity for oil will necessitate larger storage space, which in turn means a heavier platform. This results in increased requirements with regard to buoyancy, which in turn entails larger hollow spaces in the platform, which then increases the weight. In its turn this will affect the platform foundation's hydrodynamic properties, etc.

The requirements as to hydrodynamic properties during operation are

important, since both the processing equipment on the platform deck and the conditions for the work environment place demands as to maximum values for vertical movement and rolling movement and associated frequencies in different environmental situations. These environmental situations are usually defined on the basis of wave height, wave frequency and wind speed. The requirement regarding hydrodynamic properties is of special interest in the present invention.

The columns which are used according to the prior art for floating concrete platform foundations are in the form of straight cylinders, which have the advantage during production that the slipform has a constant diameter. No direct disadvantages can be singled out in this construction, since it will always be possible to satisfy the requirements for the platform foundation by constructing a sufficiently solid and heavy platform. The choice of constructional design will mainly be determined on the basis of the desire to find the solution which satisfies the requirements in the best possible manner at the lowest cost.

The object of the present invention is to provide a fundamental solution for a semi-submersible platform foundation with better hydrodynamic properties than known floating platform concepts. In practice this means a platform foundation which is less subject to the influence of waves, and also to some extent wind forces. It is a further object that this platform concept should be capable of being adapted to different deck constructions without this having any substantial effect on the platform's characteristics in other areas.

A platform foundation will thereby be provided which permits lower development costs for the oil or gas field as a whole, since the constructional and functional requirements can be satisfied at a lower cost than for platform foundations according to the prior art.

The said objects of the invention are achieved with a platform foundation of the type mentioned in the introduction which is characterized by the features which are indicated in the patent claims.

In this invention the terms "conical" and "cone-shaped" describe a geometrical body limited by a random base surface, a random top surface, and a side surface. The top surface is smaller than the base surface, and

within the scope of the invention the shape of the base surface and the top surface can be formed from curved or straight lines or a combination of these. The side surface is a continuous surface between the base surface and the top surface, formed from curved or straight surfaces or a combination of these.

"Conicity" should be understood as cone-shaped. The expression "eccentric conicity" means that the columns must not have a symmetrical cone shape, but can be slanting with an oblique centre axis.

The vertical movements of platform foundations designed according to the prior art are mainly due to the fact that the wave movements have a vertical component which gives rise to wave forces on the underside of the platform foundation. The conical design of the columns on a platform foundation according to the present invention causes the wave movements to give rise to a vertical force component on the columns. Computer analyses of the influence of the waves show that the wave forces on the underside of the platform foundation and the vertical component of the wave forces on the cone-shaped columns will coincide with regard to time, thus substantially counteracting each other, and resulting in a platform foundation with much smaller vertical movements. The vertical component of the wave forces is reduced as the depth increases, and it is therefore necessary to match the columns' conicity with the platform foundation's depth and the underside's projected area, in order to obtain the best possible balance of forces. Apart from the fact that the reduction in the vertical movement in itself is a great advantage, it means an indirect reduction in the requirements regarding buoyancy and freeboard, which in turn have a favourable effect on the stability.

Computer analyses show that a conical design of the columns gives a platform with low natural frequencies. Besides this being advantageous in itself, it reduces the possibility of excitation from the wave movements, the distance between the platform's natural frequency and the waves' frequency being increased. Thus it has surprisingly been shown that the conical or cone-shaped design of the columns gives a marked improvement in the parameters for the utilization of semi-submersible platforms.

In a platform foundation the total internal volume of the columns will be approximately based on requirements as to buoyancy, ballasting and the

capacity for oil storage. Compared with cylindrical columns the cone-shaped columns will give reduced cross sectional area at the surface of the sea where the horizontal wave forces are strongest, which means reduced horizontal movements.

The possibilities for adaptation to different deck constructions, while at the same time preserving the constructionally advantageous properties, is another essential and important feature, and this is achieved by giving the columns a greater or lesser eccentric conicity, thus making it possible to satisfy different platform decks' requirements for centre distance between the mounting points. Thus it will be a simple matter to have the foundation "tailor-made" both for existing deck concepts and specially-designed decks. The adaptation to various requirements regarding buoyancy, ballasting and storage capacity for oil can be easily achieved by increasing or reducing the columns' conicity and diameter. It is also possible to combine slanting and straight columns in one foundation.

The construction, and possibly the entire foundation, is preferably made of concrete, e.g. lightweight concrete, but steel structures will also be possible.

It can be seen that the above-described constructional design has substantial advantages compared with platform foundations according to the prior art. These advantages will become particularly apparent when the costs are compared of two equivalent platforms, one which has been built according to the prior art, and one where it has been possible to reduce the costs by implementing features based on the present invention.

The invention will now be described in more detail by means of the drawings which illustrate embodiments of the invention, and in which:

fig. 1 is a longitudinal section of a platform foundation of lightweight concrete according to the invention,

fig. 2 is a horizontal section through the pontoons and nodes of the platform foundation in figure 1,

fig. 3 is a side view of an alternative embodiment of a platform foundation of lightweight concrete according to the invention, and

fig. 4 is a side view of a second alternative embodiment of a platform foundation of lightweight concrete according to the invention.

Figures 1 and 2 illustrate a typical platform foundation 1 of lightweight concrete according to the invention with four columns 2 and four pontoons 3, connected to the columns at the nodes 4. The figures further illustrate the columns' inner chambers 5, the columns' outer chambers 6, formed by the columns' outer wall 7 and inner wall 8. Figure 3 illustrates the nodes' chambers 9 and the pontoons' chambers 10. Figure 1 also illustrates the platform deck's mounting points 11.

The embodiment shown in figures 1 and 2 clearly illustrates the cone shape of the columns. The chambers will be used for oil storage, ballast tanks and buoyancy tanks. The main principle for the use of the chambers is that the chambers in the pontoons will be used as ballast tanks, while the chambers in the columns will be used as oil storage and buoyancy tanks. By increasing or reducing the conicity of the columns, it will be possible to alter the storage capacity for oil without this having any noticeable effect on the platform foundation's other characteristics. During operation the chambers formed by the columns' double walls will act as safety zones, since any leakage either through the outer or the inner wall here will be easy to detect. During building, coupling up to the deck, towing to the installation site and operation, the platform foundation will pass through various phases where the different chambers will be employed for different purposes. In the event of a distortion which may occur during an uneven load or an accident, the columns' chambers can be ballasted to compensate for this.

The platform's hydrodynamic properties will be associated with the columns' conical shape. If the platform's natural period is over approximately 25 seconds it will not become excited by critical waves. In a typical platform designed according to figures 1 and 2 this will be achieved. If this requirement had been satisfied with straight cylindrical columns, the platform would have had to be higher, with the negative consequences this would have entailed for weight and stability.

Figure 3 shows a second embodiment, substantially corresponding to the embodiment illustrated in figures 1 and 2, where the column 2a is identical with the columns 2, but the column 2b has an eccentric conicity. By

introducing the eccentric conicity, it becomes a simple matter to adapt the platform foundation to different platform decks. In the case of a symmetrical platform deck it will be natural to introduce the same eccentric conicity for all columns, since this will naturally give equal hydrodynamic properties to all sides of the platform. However, it is natural to assume that a platform deck will have both asymmetrical shape and asymmetrical weight distribution, for example when a flame tower projects far out on one side of the platform, which can necessitate a conical eccentricity in the foundation's column, as illustrated in figure 3. A conical eccentricity can also be desirable on the basis of operating conditions, for example by allowing a supply ship to approach the deck more closely, thereby reducing the requirement for the length of the boom on the platform's crane.

Fig. 4 illustrates a further embodiment of the invention, where the eccentric conicity is even more pronounced.

The illustrated embodiments have been developed for lightweight concrete, which entails a reduction in weight and consequently a reduction in the requirements regarding buoyancy, compared with platforms made of ordinary concrete. The principles on which the invention are based, however, are independent of the construction material, and the invention is therefore not limited to the illustrated embodiments in lightweight concrete, but will apply regardless of the choice of construction material.

It will be seen that many modifications are possible within the scope of the invention. For example the platform foundation can have a different number of columns, and in principle the number can vary from one column to a large number. For reasons of stability and on the basis of practical considerations, the most obvious number, apart from four columns, will be three, five or six columns.

It will also be seen that it will be possible to increase the diameter of the columns at the top, at a certain distance above the surface of the sea. This could be desirable in some situations, for example if a deck requires to be used which needs a larger storage area, for example a concrete deck, or if the upper part of the columns requires to be used for placing equipment, for example sea water pumps or fire pumps, or storage tanks, for example for fresh water, diesel or methanol.

It will, of course, also be possible to divide the columns internally in a different way, thus obtaining a different number, shape and size of chambers. The invention is also independent of whether the columns, or the pontoons, are used as storage tanks and/or for ballasting or buoyancy. Both chambers open to the atmosphere and wet storage spaces can be employed.

These examples of modifications, and similar modifications which will be natural for a person skilled in the art, will all lie within the scope of the invention.

PATENT CLAIMS

1. A floating offshore construction, comprising a bottom part divided into chambers and with columns in the peripheral area, which project above the surface of the sea and the top area of which is designed for the installation of a deck, where the columns are cone-shaped with the smallest diameter in the upper area, preferably the top area, wherein at least one of the columns is eccentrically cone-shaped.

2. A construction according to claim 1, wherein the columns have different eccentricity.

3. A construction according to any preceding claim, wherein the columns are double-walled in the area from the bottom part to above waterline level.

4. A construction according to any preceding claim, wherein the columns are equipped with oil storage and/or ballast tanks.

5. A construction according to any preceding claim, wherein the columns can be ballasted for compensation of any load or damage distortions.

6. A construction according to any preceding claim, wherein the top part of the columns is designed for direct installation of a deck construction.

7. A construction according to any preceding claim, wherein the construction is principally made of steel.

8. A construction according to any preceding claim, wherein the construction is principally made of concrete, e.g. lightweight concrete.

9. A floating offshore construction substantially as herein described with reference to figures 1 to 4.

Patents Act 1977 Examiner's report to the Comptroller under Section 17 (The Search report)	Application number GB 9516388.7
Relevant Technical Fields (i) UK Cl (Ed.N) B7A (AAAQ) (ii) Int Cl (Ed.6) B63B 35/44	Search Examiner A HABBIJAM
	Date of completion of Search 21 SEPTEMBER 1995
Databases (see below) (i) UK Patent Office collections of GB, EP, WO and US patent specifications. (ii) ONLINE: WPI	Documents considered relevant following a search in respect of Claims :- 1-9

Categories of documents

X: Document indicating lack of novelty or of inventive step.

Y: Document indicating lack of inventive step if combined with one or more other documents of the same category.

A: Document indicating technological background and/or state of the art.

P: Document published on or after the declared priority date but before the filing date of the present application.

E: Patent document published on or after, but with priority date earlier than, the filing date of the present application.

&: Member of the same patent family; corresponding document.

Category	Identity of document and relevant passages		Relevant to claim(s)
X	GB 2001012 A	(DYCKERHOFF & WIDMANN) see buoyant bodies 3: Figure 1	1
X	GB 1094627	(KERR-McGEE CORPORATION) see columns 150 to 153: Figure 1	1
X	US 4168673	(POEPPEL) see tapering columns 1, 3: Figure 1	1
X	US 3797438	(FAYREN) see conical column 8: Figures 3 and 4	1
X	US 3490406	(O'REILLY ET AL) see conical column 16 extending from lower hull 14: Figure 1	1, 3, 6, 7

Databases: The UK Patent Office database comprises classified collections of GB, EP, WO and US patent specifications as outlined periodically in the Official Journal (Patents). The on-line databases considered for search are also listed periodically in the Official Journal (Patents).